

UNCLASSIFIED

**Defense Technical Information Center  
Compilation Part Notice**

**ADP013411**

**TITLE:** Technological Aspect of Realization of a New Concept of  
Chemical Disarmament in Russia

**DISTRIBUTION:** Approved for public release, distribution unlimited

**This paper is part of the following report:**

**TITLE:** Chemical and Biological Medical Treatment Symposium - Industry  
II World Congress on Chemical and Biological Terrorism

**To order the complete compilation report, use: ADA411272**

The component part is provided here to allow users access to individually authored sections of proceedings, annals, symposia, etc. However, the component should be considered within the context of the overall compilation report and not as a stand-alone technical report.

**The following component part numbers comprise the compilation report:**

**ADP013371 thru ADP013468**

UNCLASSIFIED

## **41. TECHNOLOGICAL ASPECT OF REALIZATION OF A NEW CONCEPT OF CHEMICAL DISARMAMENT IN RUSSIA**

Petrov V.G.  
Institute of Applied Mechanics, UB RAS  
426000, Russia, Izhevsk, Gorky St., 222

### **INTRODUCTION**

In the middle of the year of 2000 the state customer of the Program of chemical weapon destruction was changed in the Russian Federation. It was caused by the fact that the functions, connected with the realization of the Program of chemical disarmament did not belong to the sphere of activity of the former customer, the Department of the chemical and biological protection troops of the Ministry of Defense of the Russian Federation. At present the responsibility for the realization of the Program under discussion is put upon the Federal Agency on armaments headed by Zinovyev Pack.

At the present time this new state customer is changing the Concept, connected with the realization of the Program of chemical disarmament. A new Concept is directed to reduction of expenses for the Program realization. In connection with this fact the number of the chemical weapon destruction plants to be built is changed. The New Concept presupposes the construction of not more than three chemical weapon destruction plants. The alternative technologies for chemical weapon destruction are not going to be studied. The basic technologies, which are now in the process of thorough development, are going to be used.

As the number of the plants for chemical weapon destruction is planned to be reduced the expenses for the development of social sphere are going to be reduced as well. Despite of these advantages this new Concept presents certain risk connected with the necessity to transfer chemical weapons from the storages to the destruction facilities. In this case the transportation of chemical weapons will be performed over the distance equal to hundreds of kilometers through several densely populated settlements. As far as there is danger of terrorist acts under the present conditions in Russia the risk during transportation considerably increases.

Despite of this fact the presented approach under the present economic conditions seems to be quite justified. It precludes unnecessary expenses. In this paper certain technological aspects of realization of the new Concept in Russia are discussed.

### **DISCUSSION**

In Table 1 the general amount of chemical weapon in Russia and the sites of its storage are shown. From this table it can be seen that all the storage sites can be divided into three groups [1]. The first group includes the storages where chemical weapon containing blister-gases such as lewisite, yperite, yperite-lewisite mixtures are stored. They are settlement of Gorny (Saratovskaya oblast), and the town of Kambarka (the Udmurt Republic). At these storage site the poisonous substances are kept in stationary containers with capacity of several tons. The other two groups include the storage facilities where organic phosphorous substances such as sarin, zoman and V-gases are stored. These facilities represent air-forces bases and the poisonous substances there are kept in aviation shells, the mass of each shell makes up 200 kg. They are situated in the settlement of Maradykovsky (Kirovskaya oblast), the settlement of Leonidovka (Penzenskaya oblast), the town of Pochel (Bryanskaya oblast). At the other two bases that is in the settlement of Kizner (the Udmurt Republic) and the town of Shchuchye (Kurganskaya oblast), the chemical weapons are kept in artillery shells. This classification of chemical weapons according to their type and the way

of being stored will be taken into consideration when the decision will be made on what sort of facility should be constructed. If the facility is meant for blister-gases destruction it will differ from the others by the poisonous substances destruction technology. The difference between the other two will lie in the method of disassembly of the shells. This is a basic approach. However, as far as the technologies of organic phosphorous substance destruction have a lot in common, there might be only one facility constructed with the cycle including destruction and reaction mass neutralization. At the same time there is great difference between the amount of stored lewisite in the settlement of Gorny, which makes up about 200 tons of poisonous substances, and in the town of Kambarka, where there are about 6400 tons of lewisite. So there can be two facilities constructed for lewisite destruction. From what is said above it follows that the new Concept presupposes 2 or 4 destruction plants to be constructed.

Table 1. The general amount of chemical weapon in Russia and the sites of its storage.

Russian sites of CW storage	Type of Munitions	Type of Chemical Agents	Amount of CW (tons)
1.* Gorny (Saratovskaya obl.)	Bulk Containers	L, H, H-L mix	1160
2. Kambarka (Udmurt Rep.)	Bulk Containers	L	6360
3. Pochep (Bryanskaya obl.)	Air Delivered Munitions	GB, GD, Vx	6720
4. Leonidovka (Penzenskaya obl.)	Air Delivered Munitions	GB, GD, Vx	6880
5.* Maradykovsky (Kirovskaya obl.)	Air Delivered Munitions	GB, GD, Vx L, H, H-L mix	6960 800
6. Kizner (Udmurt Rep.)	Artillery Munitions	GB, GD, Vx	5680
7.* Shchuchye (Kurganskaya obl.)	Artillery Munitions	GB, GD, Vx	5440

General amount of CW in Russia - 40 000 tons

\* - Possible sites for CW destruction in new Conception in Russia

### CHEMICAL WEAPON DESTRUCTION TECHNOLOGIES

**Lewisite.** The new Concept precludes the development of the alternative lewisite destruction technologies, as it was thought previously [2]. The basic technology will be alkali hydrolysis [3], which has been better developed in comparison with any other one by the present time. But the problem of reaction mass utilization arises. The reaction masses present by themselves the solution of sodium chloride and arsenite. The process of arsenic electro-chemical reduction out of reaction masses [4] is not developed enough at present. There is the variant possible to vaporize the reaction masses till crystalline state [5]; and in this state the reaction masses may be stored till final treatment in the post-conventional time. It is also possible to utilize the reaction masses with arsenic sulphide and sodium chloride solution extraction, out of which caustic [6] can be received by electro-chemical method. To reduce the expenses on lewisite destruction it is possible to construct only one facility, which will have the complete cycle including utilization of reaction masses. At present the plant for lewisite destruction in the settlement Gorny is almost ready to be used, and in the year of 2001 it is planned to start the works on lewisite destruction. The question on the construction of the destruction facility in Kambarka is still under consideration. Right now the question of loading lewisite into transport-technological containers for further transportation is the only one, which is being under consideration.

**Yperite.** The yperite detoxification is planned to be performed with the use of the monoethanolamine and ethylene glycol mixture. The reaction mixture is going to be burnt [7]. The problem is that during this process there is a possibility of formation of such

toxicants as PCBs, PCDDs/Fs [8]. Therefore, strict attention should be paid to the special condition requirements of the process.

**Yperite-lewisite mixtures.** It is planned to melt these mixtures with sulphur and then to forward to the burial sites [7]. The main problem is safe burial of the wastes containing arsenic.

As far as yperite and yperite-lewisite mixtures are stored mainly in Saratovskaya oblast the facility for their destruction will be built there.

**Organic phosphorous substance destruction.** The Russian technology for destruction such organic phosphorous substances as sarin, zoman (which are according American classification GB, GD) presents by itself two-stage process; at the first stage at the temperature 110 C the interaction of reagent with monoethanolamine in the presence of water takes place [9, 10]. Then to the received reaction mass the mixture of bitumen and calcium hydroxide is added at the temperature of about 200 C, and this is the second stage. After cooling the product of the second stage hardens and the received material is called "bitumen-salt mass", which is supposed to be forwarded to the burial place, since it has been proved to belong to the IV class of danger it is possible to bury it at the polygon of burial of solid household wastes.

For V-gases destruction also the two-stage process is planned to be used. At the first stage the detoxification of these poisonous substances will be performed with the use of N-methylpyridilnon, kalium isobutylate and isobutyl alcohol mixture at the temperature of about 90 C. At the second stage the received reaction mass is added to hot bitumen and the process is conducted at the temperature of 180 C during 3 - 45 minutes. After the reaction is over the bitumen-salt mass is poured out of the reactor and cooled, it results in hard material, which can be also considered as belonging to the IV class of danger [10].

The second stages in the Russian technologies of organic phosphorous poisonous substance destruction puts forward a lot of questions: the process of bituminization followed by burial of bitumen-salt masses on special polygons, which will be located close to chemical weapon destruction facilities. Though these masses are classified as low-toxic substances, however it is known that during long-lasting storage bitumen matrix is destroyed after which various salts, including toxic substances can be washed out of it and penetrate into the environment, since according to some data [1] reaction masses after the first stage of the processes may be considered as belonging to the I class of danger. At the second stage final chemical weapon destruction is likely to take place, however it is not clear how toxicity of the formed substances can be lowered. It is possible that simple dilution of the first stage reaction masses with bitumen and reduction of their mobility because of formation of hard bitumen-salt matrix plays here a certain role. If at the second stage of sarin and zoman destruction the additional treatment with calcium hydroxide takes place, for V-gases destruction this is not done.

Then we can state that the toxicity of bitumen-salt masses during destruction of these substances can vary as well. The total amount of bitumen-salt masses is five or six times higher than the initial amount of poisonous substances. It seems that further use of these bitumen-salt masses is scarcely possible.

The alternatives to this technology or at least to its second stage might be certain thermal methods [11], burning [12], use of plasma [13]. It is connected with the fact that eventual treatment of the covers of chemical shells and containers where poisonous substances were held should be performed thermally. In this case the destruction technology of poisonous substances and the objects having been in contact with them will be performed within the framework of one and the same technological process, which can simplify

considerably the arrangement of works, and the amount of solid wastes will be significantly reduced as well.

As the second stage of the organic phosphorous substance destruction processes arise a lot of questions, it is quite possible that for realization of the conventional tasks only the first stage of the processes will be fulfilled. The received reaction masses will be stored and their destruction will take place only in post-conventional period of time. In particular, for this purpose the existing installations for damaged ammunition destruction KUASI can be used.

The organic phosphorous substance destruction facility is being built at the present moment in the town of Shchuschye. It is meant for destruction of the ammunition of barrel and reactive artillery. Probably, the chemical weapons stored in the settlement of Kizner will be transported to the town of Shchuschye for destruction, because Kizner chemical weapons are similar to the ones stored there. At present the question concerning air force bases elimination is not solved yet. In particular, the question of realization of the first stage of the process with the use of installation KUASI in the settlement of Maradykovky is being under consideration at the present moment.

#### **The questions of safe transportation of chemical weapons**

The problem of safe transportation of chemical weapons at realization of the new Concept is one of the most essential. Especially it is connected with the threat of terrorist acts. The case in Tokyo underground shows that on such an occasion the quantity of victims can be considerably larger, than in the case of terrorist act when chemical weapons are not involved [14], this might seem quite attractive for terrorists. If in Tokyo underground the self-made poisonous substance of low quality was used which led to death of comparatively small number of victims, in case if war chemical agents are used it may cause death of a great number of people. Taking into consideration that transportation of chemical weapons will be realized by the railroad transport, and they will be carried through the whole number of densely populated sites, such a threat is rather essential.

In connection with this problem it is necessary to consider the general approach to chemical weapon transportation. In fig. 1 the location of chemical weapon storages and the intensity of terrorist act occurrence in the present Russia are shown. From this figure it can be seen that the greatest intensity of terrorist acts takes place in western and southern part of European part of Russia. Thus, the general approach, reducing the threat of terrorist acts at chemical weapon transportation should be as follows: the directions of the routes of transportation in Russia should be from the West to the East and from the South to the North, since in this case the transportation of chemical weapons will be performed in the direction of the most quiet regions.

If we consider the existing facilities of storage of chemical weapons on the basis of which the destruction facilities are to be built according to the new Concept, then we can say that best of all this requirement is met by the facilities in Schuschye (Kurganskaya oblast) and in the settlement of Maradykovsky (Kirovskaya oblast) where organic phosphorous substances are being stored. In this case chemical weapon transportation from Udmurtia will be carried out to the East, and from Bryanskaya and Penzenskaya oblasts to the East and to the North. Therefore from the point of view of safe transportation it is quite reasonable that chemical weapon destruction plant is being built in the town of Schuschye, and the fact that some attempts to destruct chemical weapons in the settlement of Maradykovsky are being made seems to be reasonable as well. As for lewisite in this case the transportation from Udmurtia is supposed to be performed to Saratovskaya oblast, that means to the West and to the South. In this case the transportation is connected with a certain risk. Therefore, it is

necessary to consider the possibility of carrying out at least the first stage - detoxification of lewisite in Kambarka in order to transport only the reaction masses, which are much less dangerous in the case of a terrorist act.



Fig.1 The location of CW storages and the intensity of terrorist acts occurrence in the present Russia.

#### RUSSIAN SITES OF CW STORAGE

- 1.\* Gorny (Saratovskaya obl.); 2. Kambarka (Udmurt Rep.).
3. Pochep (Bryanskaya obl.); 4. Leonidovka (Penzenskaya obl.);
- 5.\* Maradykovsky (Kirovskaya obl.).
6. Kizner (Udmurt Rep.); 7.\* Shchuchye (Kurganskaya obl.).

#### Intensity of terrorist acts:

- - more than 10 incidents per year;
- ▨ - less than 10 incidents per year;
- , - territory without terrorism incidents

## TRANSPORTATION OF CW

(2) → 1\* ; (3,4) → 5\* ; (6) → 7\*.

\* - Possible sites for CW destruction in new Conception in Russia

It is also necessary to consider certain technical question of transportation. The transportation of lewisite is to be carried out in special transport-technological containers, which are fire- and explosion-proof having the capacity of 1 cubic meter. In the old Concept it was supposed to use such containers for transportation of lewisite from the site of its storage to the destruction facility over the distance of 2 - 3 kilometers. Since according to the new Concept it is planned to transport over large distances, obviously we should reconsider technical requirements to the containers, which must be stricter. And it is obvious that the larger number of such containers should be made as the time of transportation will increase which means that the time of use of the containers will increase as well. The use of such containers for organic phosphorous substances arises certain questions. It is possible to use these containers for transportation of the artillery shells. In this case there is no need to disassemble them; they should be immersed into degassing solution. More complicated problem is transportation of substances from air force containers, which have the capacity of 200 kg of poisonous substances. In this case it seems more reasonable to carry out preliminary dissembling of the containers and to perform the first stage of neutralization. The reaction masses to be transported though having high toxicity are not chemical weapons any more.

## MODERN SAFETY SYSTEMS

As we have mentioned earlier [15] at present in Russia there are no up-to-date safety systems, based on the use of computers, modern multi-channel means of communication and poisonous substance detection methods. For the new Concept the amount of such systems should be considerably enlarged. They should be created not only for the use at storage facilities but also for the places through which the chemical weapon transportation will be performed, especially for densely populated places. The mobile systems should be as well, which will move alongside with chemical weapons. The number of special groups of people responsible for safe transportation of chemical weapons must be increased. Besides, it is necessary to conduct special training course for the population of the towns through which the transportation will be carried out that people will have necessary skills for proper acting in case of chemical danger. Only these measures will reduce the threat of terrorist acts, technogenic and natural accidents, which can influence safety of chemical weapon transportation.

## CONCLUSIONS

Despite of economic advantages offered by the new Concept on the chemical disarmament in Russia, there are still certain things, which must be considered in connection with safety of works on chemical weapon destruction and the threat of terrorist acts:

- The single safety system for transportation must be created, which will include the necessity of creation of safety systems at chemical weapon storages, at chemical weapon destruction facilities and at the places through which the transportation will take place; the number of groups of people responsible for safety and elimination of the consequences of accidents must be increased.
- It is necessary to make technical requirements to the transport-technological containers stricter and to enlarge the number of such containers;

- It is necessary to consider the possibility of carrying out the first stage of poisonous substance neutralization at a number of chemical weapon storages in order to make it possible to transport only the reaction masses.

## REFERENCES

1. Fedorov L.A. The proceedings of NBC Defence'97, Symposium. Hyvinkaa, Finland, 1997, p.49-54.
2. Petrov S.V. Russian Chemical Journal, v.39, N 4, 1995, p.4.
3. Petrunin V.A., Baranov Yu.I., Kuznetsov B.A. Russian Chemical Journal, v.39, N 4, 1995, p. 15-17.
4. Umyarov I.A., Kuznetsov B.A., Krotovich I.N. Russian Chemical Journal, v.37, N 3, 1993, p.25-29.
5. Rusanov V.M., Smetanin A.V. Thesis of Reports 1-st Udmurtian seminar on problems of CWD, Izhevsk, Russia, 1994, p.119-120.
6. Petrov V.G., Trubachev A.V. The proceedings of CBMT Symposium-Industry I, Zagreb-Dubrovnik, Croatia, 1998, p.253-257.
7. Luganskiy I.N., Sheluchenko V.V., Krotovich I.N. Russian Chemical Journal, v.38, N 2, 1994, p.34-36.
8. Petrov V.G., Trubachev A.V. The proceedings of NBC Defence'97 Symposium, Hyvinkaa, Finland, 1997, p.57-60.
9. Zhdanov V.A., Koshelev V.M., Novikov V.K., Shuvalov A.A. Russian Chemical Journal, v.37, N 3, 1993, p.22-25.
10. Joint Evaluation of the Russian Two-Stage Chemical Agent Destruction Process. Final Joint Evaluation Technical Report. Edgewood. USA. 1996, 97 p.
11. Bokarev V.A., Kalashnikov I.V. Thesis of Reports CHEMDET'96 Conference, Izhevsk, Russia, 1996, p.91-92.
12. Udaltsova G.Yu., Tankovich N.A., Lyangasov L.P. Russian Chemical Journal, v.37, N 3, 1993, p.17-22.
13. Gonopolsky A., Panfilov S., Sakulin G., Seleznev L. CW and the problems of its destruction, PIR Center, N 6, 1998/1999, p.2-5.
14. Anthony T.Tu. Archives of Toxicology, Kinetics and Xenobiotic Metabolism, v.7, N 3, 1999, p.45-84.
15. Petrov V.G., Trubachev A.V. The proceedings of NBC 2000 Symposium, Jyvaskyla, Finland, 2000, p. 81-88.